Texas Higher Education Coordinating Board

Making Opportunity Affordable in Texas:

A Student-Centered Approach

Tuning of Industrial Engineering

Texas Higher Education Coordinating Board

Austin, Texas

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* Prerequisite Flowchart on page 26 revised 11/15/2013.

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Industrial Engineering Committee

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Table of Contents

Definition of Tuning

"Tuning" is a faculty-led pilot project designed to define what students must know, understand, and be able to demonstrate after completing a degree in a specific field, and to provide an indication of the knowledge, skills, and abilities students should achieve prior to graduation at different levels along the educational pipeline – in other words, a body of knowledge and skills for an academic discipline in terms of outcomes and levels of achievement of its graduates.

Tuning provides an expected level of competency achievement at each step along the process of becoming a professional: expectations at the beginning of pre-professional study, at the beginning of professional study, and at the transition to practice. It involves seeking input from students, recent graduates, and employers to establish criterion-referenced learning outcomes and competencies by degree level and subject area. Through Tuning, students have a clear "picture" of what is expected and can efficiently plan their educational experience to achieve those expectations. The objective is not to standardize programs offered by different institutions but to better establish the quality and relevance of degrees in various academic disciplines. An overview of Lumina Foundation for Education's "Tuning USA" Initiative is available at: http://www.luminafoundation.org/our_work/tuning/; an overview of Tuning work to date in Texas is available at: http://www.thecb.state.tx.us/tuningtexas.

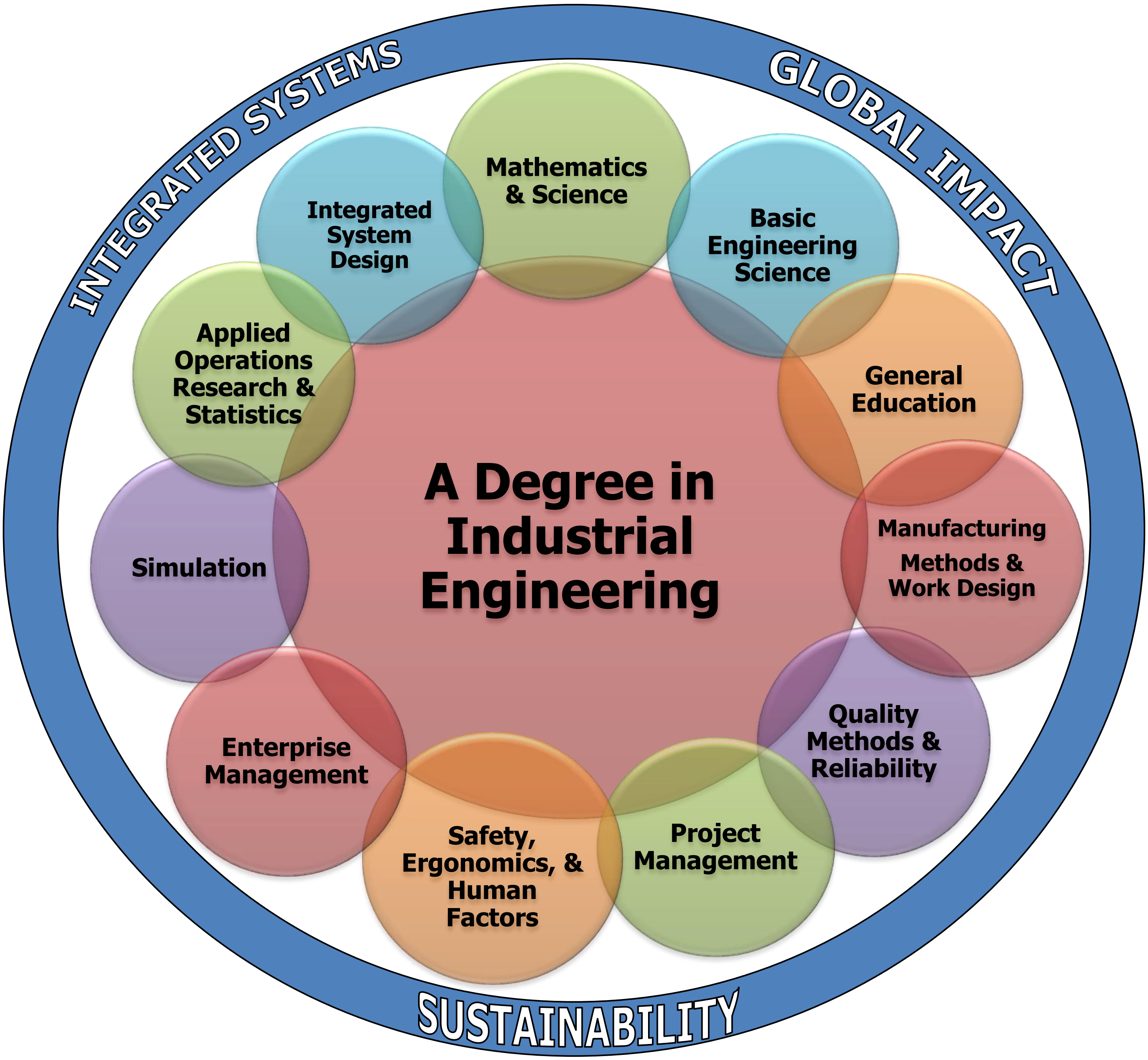
Definition of Industrial Engineering

Industrial engineering is a branch of engineering dealing with the optimization of complex processes or systems. It is concerned with the development, improvement, implementation, and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis, and synthesis. The industrial engineer incorporates the mathematical, physical, and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes.

Industrial and Systems Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, equipment, information, and energy. In short, Industrial Engineering makes things better, faster, and less expensive.

Industrial Engineering Expertise Profile

The expertise profile lists types of course work necessary for the completion of a baccalaureate degree in industrial engineering. Note: General undergraduate degree requirements (i.e., the core curriculum) are not considered for the purpose of tuning the industrial engineering discipline.



Industrial Engineering Employment Profile

The employment profile lists 12 potential employment pathways for industrial engineers. Core skills and applications include: systems thinking, enterprise management, problem solving, decision analysis, leadership, quality management, work processes, design for people, international support, and logistics.

Industrial Engineering Competency Table

The ABET-defined learning outcomes for 2011-12 are defined in Criterion 3: *Student Outcomes as follows:*

"Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program."

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) an ability to function on multidisciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) a recognition of the need for, and an ability to engage in, lifelong learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Source: http://www.abet.org/Linked%20Documents-UPDATE/Program%20Docs/abet-eac-criteria-2011-2012.pdf

This document interprets these outcomes for Industrial Engineering.

The Industrial Engineering competency table has twelve learning outcome titles:

1. Math, Science, and Engineering
2. Experiments
3. Design a system, component, or process
4. Multidisciplinary teams
5. Engineering problem solving
6. Professional and ethical responsibility
7. Communication
8. Global impact of engineering solutions
9. Lifelong Learning
10. Contemporary issues
11. Engineering tools
12. Integrated Systems Design

Industrial Engineering Key Competencies Profile

The key competencies profile is a schematic diagram that is derived from the competency table. It lists, for each learning outcome (columns), the required competency levels according to Bloom's taxonomy (rows) that must be gained at each of five educational levels:

1. secondary education competencies, marked "HS"
2. pre-engineering competencies, marked "CC"
3. baccalaureate-level competencies, marked "BS"
4. graduate-level competencies, marked "G"
5. graduate- and/or experience-level engineering competencies, marked "G/Ex"

The level of response for each of the Bloom's taxonomy levels is described through active verbs; examples of verbs for each level can be found at:

http://www.teach-nology.com/worksheets/time_savers/bloom/

Industrial Engineering Key Competencies Diagram

Lumina Foundation Grant Industrial Engineering Committee

Evaluation	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex
Synthesis	G/Ex	BS	BS	G/Ex	G/Ex	G/Ex	G/Ex	G/Ex	BS	G/Ex	G/Ex	G/Ex
Analysis	G/Ex	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS
Application	BS	BS	BS	BS	BS	BS	CC	BS	BS	BS	BS	BS
Comprehension	CC	CC	BS	BS	BS	CC	HS	BS	CC	CC	BS	BS
Knowledge	HS	HS	CC	HS	HS	CC	HS	HS	HS	HS	CC	BS
	Apply Mathematics, Science, and Engineering Knowledge	Design and Conduct Experiments	Design a System, Component, or Process	Multidisciplinary Teams	Solve Engineering Problems	Professional and Ethical Responsibility	Communication	Global Impact of Engineering Solutions	Lifelong Learning	Contemporary Issues	Engineering Tools	Integrated System Design

G/Ex	**graduate- and/or experience-level competencies**
G	**graduate-level competencies**
BS	**baccalaureate-level competencies**
CC	**pre-engineering competencies**
HS	**secondary education competencies**

Explanation of Industrial Engineering Student Outcomes

The Industrial Engineering competency table has five learning outcome categories:

1. core competencies needed to enter higher education in industrial engineering
2. pre-engineering competencies gained during the first two years (associate's degree) of study
3. baccalaureate-level engineering competencies
4. graduate-level engineering competencies
5. graduate- and/or experience-level engineering competencies

Mathematics, Science, and Engineering

a): Industrial engineers have an ability to apply knowledge of mathematics, science, and engineering to the solution of practical problems.

Engineering students are generally trained as problem solvers in the sense that they are capable of leveraging STEM (science, technology, engineering, mathematics) knowledge to develop new technologies, improve existing designs, and accomplish complex engineering projects. As the design complexity and system integration increase, engineering students are expected to be equipped with a broad spectrum of STEM knowledge as well as interdisciplinary trainings.

Industrial engineering students play a pivotal role in sustaining the technological advancement, process improvement, and betterment of human living quality. They have the capability to apply various analytical skills, including operations research and statistics, to model large and complex problems, identify the design constraints, and find the best comprised solution.

MATHEMATICS, SCIENCE, AND ENGINEERING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate-and/or Experience-Level Engineering Competencies**
Define key factual information related to mathematics through calculus, physics, chemistry, and one additional area of science	Explain key concepts and problem-solving processes in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	Solve problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	*Intentionally left blank*	Analyze a complex problem to determine the relevant mathematical and scientific principles; then apply that knowledge to solve the industrial engineering problem
				Create new mathematical or scientific knowledge in the industrial engineering field
				Evaluate the validity of newly-created mathematical or scientific knowledge in the industrial engineering field

Experiments

b): Industrial engineers have an ability to design and conduct experiments, as well as to analyze and interpret data.

Good engineering designs typically are established upon scientific theories along with solid experimental testing. Both the reliability and the performance of a new design can be verified and validated through laboratory experiments or field testing. Based on the outcome of the experiment, the product or system can be further enhanced by eliminating the design weakness, adopting new processes or technologies, or using new materials.

Industrial engineering students should be prepared with necessary skills for designing cost-effective experiments and performing data analysis using basic statistical tools and models. The purpose of the experiments is to identify key factors and/or their interactions which have major impact on the quality, reliability, and performance of the products. It is also important for industrial engineering students to carry out optimal experiments to obtain the necessary data sets while using minimum resources, costs, and energy.

EXPERIMENTS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate-and/or Experience-Level Engineering Competencies**
Identify the procedures and equipment necessary to conduct experiments, recognize the need to conduct experiments, formulate a hypothesis, and select an appropriate statistic to test the hypothesis and conduct the experiment	Explain the purpose, procedures, equipment, and practical applications of industrial engineering experiments; communicate the results of the experiment and suggest appropriate courses of action	Conduct industrial engineering experiments according to established procedures and report the results; implement the appropriate course of action dictated from an experiment and determine an appropriate process to monitor the stability of the solution as systemic behavior	*Intentionally left blank*	Evaluate the effectiveness of a designed experiment in meeting an ill-defined real world need; determine the optimal system definition; implement, monitor, and control the stability of the system
		Conduct industrial engineering experiments according to established procedures, and analyze and interpret the results; make decisions on course of action based on the monitoring of the system behavior		
		Design an industrial engineering experiment to meet a need, conduct the experiment, and analyze and interpret the resulting data; recognize the need for more extensive experimentation, formulating a designed experiment to optimize the system behavior		

Design a System, Component, or Process

c): Industrial engineers have an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Design problems are typically ill-defined. The engineering design process is often an iterative process that may require the development of new knowledge. It can include the steps of problem definition, development of alternatives or design options, analysis, predictive comparison of options, selection of recommendations, implementation, and analysis of actual versus predicted performance.

For industrial engineers, the design process begins with understanding the needs and wants of the customer, and the root causes of the true problem. Options will frequently have dimensions of money, time, quality, capacity, impact on workers, and physical characteristics such as size or weight. Recommendations should address the constraints of the problem. Typically, the recommendations are based on an analysis of tangible factors (such as economic, performance, and life cycle) and intangible factors (including acceptance by workers, environmental, political, and ethical.

DESIGN A SYSTEM, COMPONENT, OR PROCESS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate- and/or Experience-Level Engineering Competencies**
Intentionally left blank	Define engineering design; list the major steps in the engineering design process; list constraints that affect the processes and products of engineering design	Describe the engineering design process; explain how real-world constraints affect the processes and products of engineering design	*Intentionally left blank*	Evaluate the design of a complex system, component, or process to ensure that it meets a client's needs and accounts for all relevant constraints
		Design a simple component or process (e.g., an inventory policy) to meet a well-defined set of requirements and constraints		
		Design a system or process (e.g., an inventory system to reduce costs, out of stock, or average inventory levels) within a well-defined set of requirements and constraints		
		Design a complex system or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability		

Multidisciplinary Teams

d): Industrial engineers have the ability to participate effectively as team members in group projects.

Industrial engineers are able to optimize group dynamics in order to maximize production by resolving problems efficiently. They will cooperate by accepting divergent ideas, encouraging active participation of team members, resolving conflicts, and taking active leadership roles.

Industrial engineers must possess an understanding of group dynamics; namely, how to create a group climate that encourages success, how to recognize and effectively utilize resources in group activities with a minimal amount of activity/task overlap, and how to use communication strategies for dealing productively with conflicts. Industrial engineers must demonstrate the skills necessary to participate effectively as team members in long-term group projects. These skills include cooperating and keeping involved and updated, accepting divergent views/opinions, encouraging active participation of team members, resolving conflict, and taking leadership roles.

Industrial engineers must show the skills necessary to work successfully with people performing a variety of functions within a group. These skills include exhibiting respect for people and the diversity in the group, accepting and incorporating appropriate thoughts/ideas from group members with different perspectives, and educating team members and sharing knowledge. Industrial engineers must report and share experiences from the group effort; namely, highlight positive experiences, discuss negative experiences, and propose ideas to improve productivity and avoid repetition of the experience for others.

MULTIDISCIPLINARY TEAMS

Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during the first two years of study	Baccalaureate-Level Engineering Competencies	Graduate-Level Engineering Competencies	Graduate-and/or Experience-Level Engineering Competencies
List the key characteristics of an effective multidisciplinary team	*Intentionally left blank*	Explain the factors affecting the ability of a multidisciplinary team to function effectively	*Intentionally left blank*	Create and organize a multidisciplinary team to accomplish a complex task
		Function effectively as a member of a multidisciplinary team		Evaluate the composition, organization, and performance of a multidisciplinary team in accomplishing a complex task
		Organize an existing multidisciplinary team to accomplish a complex task		

Engineering Problem Solving

e): Industrial engineers have an ability to identify, formulate, and solve engineering problems.

Engineering problems require the appropriate use of science, mathematics, and technology to address some need. Engineers must be able to combine background knowledge, critical thinking, and creativity to understand the conditions leading to this need and define the constraints and requirements of the problem. Engineers must be able to translate this understanding into an appropriate problem statement. Engineers then must apply their skills and tools to identify feasible solutions and make recommendations based on experimentation and analysis, as appropriate.

Industrial engineers typically work with problems that improve efficiency, increase quality, optimize the use of resources, enhance worker safety and well-being, and improve the competitive position of an organization. Industrial engineers frequently work closely with people to identify opportunities for improvement and recognize and resolve unmet needs. Industrial engineers understand how systems and processes work to make things better and to increase the quality of a service experience. In addition to a firm grasp of engineering fundamentals and analytical techniques, industrial engineers can design experiments to provide new understanding and solve new problems.

Professional and Ethical Responsibility

f): Industrial engineers have an understanding of professional and ethical responsibility

Engineers must be trained in (i) identifying professional and ethical challenges that frequently come up during their professional careers, and (ii) making informed decisions to resolve such problems.

Industrial engineers must demonstrate an ability to make informed ethical choices in solving industrial engineering problems. Industrial engineers must demonstrate knowledge of the industrial engineering professional code of ethics. Industrial engineers must demonstrate an ability to evaluate the ethical dimensions of professional practice in solving industrial engineering problems and implementing solution procedures in industry. Industrial engineers must demonstrate ethical and professional behaviors in dealing with peers, faculty, and sponsors.

ENGINEERING PROBLEM-SOLVING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first the two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate-and/or Experience-Level Engineering Competencies**
Intentionally left blank	Able to identify and communicate the existence of an engineering problem and determine an appropriate general course of action to take in finding a solution to the problem	Formulate the problem from the abstract description to scientific/ mathematical models and specify at least one solution methodology	Determine innovative methodologies to solve and implement solutions to engineering problems leading to discoveries in the field	Determine innovative methodologies to solve and implement solutions to engineering problems leading to discoveries in the field
		Find and implement a solution specifying and controlling the costs and technical validity of the solution		Determine the best possible solution to the problem evaluating the sensitivity of the solution and defining courses of action for adverse situations
		Specify multiple solution methodologies if they exist and determine the best course of action based on a set of selected criteria		

Communication

g): Industrial engineers have an ability to communicate effectively in written and verbal forms.

Industrial engineers will demonstrate an ability to communicate effectively any piece of information about a given project. Environmental protection, use of expert systems, and process optimization are topics of great importance for the industrial engineers of today. Being able to explain constraints, advantages, disadvantages, benefits, or simply to provide accurate information about the field is of vital importance to any industrial engineer. Stakeholders should have no difficulty understanding the message being conveyed by the industrial engineer. An industrial engineer shall possess a parallel vocabulary between technical and non-technical terms. Most of the time, industrial engineers need to explain technical aspects of a project in practical and understandable English. However, industrial engineers will also have to collect raw data from stakeholders in order to define, formulate, and implement a solution to a given problem.

Communication skills have to be constantly improved for an industrial engineer to be at a competitive level. Verbal, written, virtual, and graphical communication skills need to be growing as the individual develops through a college education. The use of expert systems is inevitable, but it is also a great tool for industrial engineers to sharpen these skills. For example, Project Manager is a program tool that necessarily helps students to develop all communication skills. Industrial engineers input all sorts of parameters into

PROFESSIONAL AND ETHICAL RESPONSIBILITY

Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during the first two years of study	Baccalaureate-Level Engineering Competencies	Graduate-Level Engineering Competencies	Graduate-and/or Experience-Level Engineering Competencies
	Explain the professional and ethical responsibilities of an engineer	Analyze a complex situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action		Self-assess their long-term professional and ethical development and evaluate both in light of competing and complex real-world alternatives

COMMUNICATION

Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during the first two years of study	Baccalaureate-Level Engineering Competencies	Graduate-Level Engineering Competencies	Graduate-and/or Experience-Level Engineering Competencies
List the characteristics of effective verbal, written, and graphical communications	Correctly apply the rules of grammar and composition in verbal and written communications; apply appropriate graphical standards in preparing engineering drawings, flow charts, and other forms of graphical communications	Organize and deliver effective verbal, written, and graphical communications	*Intentionally left blank*	Plan, compose, and integrate the verbal, written, and graphical communication of a complex project to technical and non-technical audiences
Describe the characteristics of effective verbal, written, and graphical communications				Evaluate the effectiveness of the integrated verbal, written, and graphical communication of a complex project to technical and non-technical audiences

Program Manager, and the program produces a number of graphs, charts, and tools that provide the industrial engineer with useful analytical tools. At the same time, the industrial engineer has to stay in control of the project and remain willing and ready to inform any stakeholder about any issue at any time.

Ideally, students should be involved as early as possible in all aspects of the profession. Attending conferences, hosting workshops, and writing professional reports are ways by which students can work their way up to success.

Impact of Engineering Solutions

IMPACT OF ENGINEERING SOLUTIONS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate- and/or Experience-Level Engineering Competencies**
Identify global, economic, environmental, and societal impacts of engineering solutions	*Intentionally left blank*	Explain the global, economic, environmental, and societal impacts of engineering solutions	*Intentionally left blank*	Develop a complex engineering solution that appropriately accounts for the global, economic, environmental, and societal impact
		Determine the global, economic, environmental, and societal impacts of a specific, relatively-constrained engineering solution		Develop and evaluate the effectiveness of a complex engineering solution that appropriately accounts for the global, economic, environmental, and societal impact
		Analyze a complex engineering solution to determine its global, economic, environmental, and societal impacts		

h): Industrial engineers have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

Life in nearly every part of the world is affected by the human development made possible by engineering. Engineered products and services impact society, the environment, the economic prosperity of individuals and nations, and have ramifications on Earth and beyond.

Industrial engineers play a key role by managing supply chains that reach around the world, improving the quality of workers' lives, integrating activities and systems in multiple countries, and increasing the wealth of people and organizations worldwide. Industrial engineers possess a broad foundation of social sciences and the humanities to engineer products and services that satisfy the needs of a sustainable planet.

Lifelong Learning

i): Industrial engineers recognize the need for, and an ability to engage in, professional development in industrial engineering.

Industrial engineers are expected to demonstrate an ability to engage in lifelong learning throughout their professional careers to keep up with technological advances in the field and use the skills for career advancement.

Industrial engineers must demonstrate the ability to use critical information-seeking tools that enable them to continue to stay up-to-date in the profession. These tools should include internet resources, professional and technical journals, handbooks, etc. Industrial Engineering graduates must show a degree plan in which elective courses have been selected based on professional goals and aspirations. Industrial engineers must demonstrate active involvement in the profession through membership in engineering societies, achievement and maintenance of professional registration for engineers, involvement in continuing education, etc. Industrial engineers must express both a full appreciation of the need for, and the motivation to pursue, further education and training, not only in engineering, but also in areas outside engineering, math, and science.

Contemporary Issues

j): Industrial engineers have knowledge of contemporary issues in the practice of engineering.

Engineers are expected to be informed about contemporary issues, which include not only math, science, engineering skills and knowledge, but also advances in domain-specific rules and regulations, government and international rules and regulations, public policy, and a variety of other disciplines.

Industrial engineers must show that they have taken and performed adequately in a variety of university courses that are concerned with contemporary issues and/or the context for understanding those issues, including courses in the humanities, performing arts, and social sciences. Industrial engineers must demonstrate the ability to evaluate the socio-economic, political, and environmental implications of proposed technical solutions.

LIFELONG LEARNING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate- and/or Experience-Level Engineering Competencies**
Define lifelong learning	Explain the need for lifelong learning and describe the skills required of a lifelong learner	Demonstrate the ability to learn on one's own, without the aid of formal instruction	*Intentionally left blank*	Self-assess their learning processes and evaluate them in light of competing and complex real-world alternatives
		Analyze a complex problem to differentiate between aspects that are already known and aspects that must be learned in order to solve the problem		Evaluate the extent to which all relevant contemporary issues have been incorporated into the identification, formulation, and solution of an industrial engineering problem
		Develop a plan to acquire the expertise necessary to solve a complex problem		

Engineering Tools

k): Industrial engineers have the ability to put into practice techniques, skills, and modern engineering tools learned in school.

The curriculum must prepare graduates to apply techniques, skills, and engineering tools appropriate to generate feasible solutions to problems. The curriculum must include instruction in information technology, manufacturing, and human factors. Software and equipment should be introduced and its use developed through the curriculum.

Industrial engineers work in a wide variety of settings to make things better, faster, and less expensive. Industrial engineers use information technology and modeling software to find optimal solutions and integrate systems. They understand manufacturing processes so they can design better ways to make products faster and more cost-effectively. They keep people and the environment safe by finding better ways to work. In

ENGINEERING TOOLS

Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during the first two years of study	Baccalaureate-Level Engineering Competencies	Graduate-Level Engineering Competencies	Graduate- and/or Experience-Level Engineering Competencies
Intentionally left blank	Identify the techniques, skills, and modern engineering tools that are necessary for engineering practice	Explain how these techniques, skills, and modern engineering tools are used in engineering practice	Create new or improve techniques and tools to solve a complex problem	Evaluate the effectiveness of techniques and tools that have been developed to solve a complex problem
		Apply relevant techniques, skills, and modern engineering tools to solve a simple problem		
		Select and organize the relevant techniques, skills, and modern engineering tools to solve a complex problem		

Core Competencies Needed to enter Higher Education in Industrial Engineering	Competencies gained during the first two years of study	Engineering Competencies	Engineering Competencies	Experience-Level Engineering Competencies
List contemporary issues that affect engineering pr	Explain how contemporary issues affect the identification,	Incorporate specific contemporary issues into the identification, formulation, and solution of a specific industrial engineering problem	*Intentionally left blank*	Synthesize the influences of all relevant contemporary
		Analyze the global, regional, and local situation to determine which contemporary issues will affect the identification, formulation, and solution of an industrial engineering problem		formulation, and solution of an industrial engineering problem

practice, industrial engineers continue to learn to develop and use new tools, skills, and techniques.

Integrated System Design

Note: ABET outcome l): Industrial engineers have a breadth of technical knowledge required to create integrated systems designs.

The curriculum must prepare graduates to design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy. The curriculum must include in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices.

Industrial engineering design problems typically involve creating or improving systems or processes that include people, materials, information, equipment, and energy. The design process starts with defining the problem or the objective to be achieved. Then constraints on costs, space, equipment, work rules, etc. must be determined. Alternative designs are created and evaluated. This entire design process, from problem definition to evaluation of alternatives, is iterative in nature and should involve a multidisciplinary approach with consideration of user acceptability, user friendliness, economy, reliability, maintainability, and quality. Hence, a breadth of technical knowledge is required to create integrated systems designs.

INTEGRATED SYSTEMS DESIGN				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during the first two years of study**	**Baccalaureate-Level Engineering Competencies**	**Graduate-Level Engineering Competencies**	**Graduate- and/or Experience-Level Engineering Competencies**
Intentionally left blank	*Intentionally left blank*	Define key factual information in a specialized area of industrial engineering	*Intentionally left blank*	Design complex systems or processes or create new knowledge within a specialized area of industrial engineering
		Explain key concepts and problem-solving processes in a specialized area of industrial engineering		Evaluate the design of a complex system or process, or evaluate the validity of newly-created knowledge within a specialized area of industrial engineering
		Solve simple problems in a specialized area of industrial engineering		
		Analyze a complex system or process involving a specialized area of industrial engineering		

Outcomes Alignment with ABET Criteria

The chart below shows how these outcomes align with ABET criteria:

Program Outcomes	ABET Reference
1. Apply Mathematics, Science, and Engineering Knowledge	a) an ability to apply knowledge of mathematics, science, and engineering to solve industrial engineering problems in varied sectors of industry;
2. Design and Conduct Experiments	b) an ability to design experiments, collect data, analyze data, and interpret results obtained;
3. Design a System, Component, or Process	c) an ability to obtain client requirements and design a system, component, or process related to industrial engineering to meet client requirements;
4. Multidisciplinary Teams: Participate as an Effective Team Member	d) an ability to obtain client requirements and design a system, component, or process related to industrial engineering to meet client requirements;
5. Solve Engineering Problems	e) an ability to identify, formulate, and solve industrial engineering problems;
6. Understand Professional and Ethical Responsibility	f) an understanding of professional and ethical responsibility;
7. Communication	g) an ability to communicate effectively in written and verbal forms;
8. Understand Global Impact of Engineering Solutions	h) the broad education necessary to understand the impact of engineering solutions in a global and societal context;
9. Engage in Lifelong Learning	i) a recognition of the need for—and an ability to engage in—professional development in industrial engineering;
10. Knowledge of Contemporary Issues	j) familiarity with current and emerging topics in industrial engineering;
11. Skills for Engineering Practice	k) an ability to put into practice techniques, skills, and modern engineering tools learned in school;
12. Create Integrated Systems Designs	l) industrial engineers have a breadth of technical knowledge required to create integrated systems designs.

Community College Program of Study for Transfer to an Industrial Engineering Program

FRESHMAN YEAR

First Semester (Fall)

	Course	SCH
MATH 2413	Calculus I	4
CHEM 1311	General Chemistry	3
CHEM 1111	Chemistry I Laboratory	1
ENGR 1201	Introduction to Engineering	2
XXXX ####	Texas Core Curriculum Requirement	3
XXXX ####	Texas Core Curriculum Requirement	3
	Semester Credit Hours	**16**

Second Semester (Spring)

	Course	SCH
MATH 2414	Calculus II	4
PHYS 2325	University Physics I	3
PHYS 2125	University Physics I Laboratory	1
ENGR 1304	Engineering Graphics	3
XXXX ####	Texas Core Curriculum Requirement	3
XXXX ####	Texas Core Curriculum Requirement	3
	Semester Credit Hours	**17**

SOPHOMORE YEAR

First Semester (Fall)

	Course	SCH
MATH 2415	Multi-Variable Calculus (Calculus III)	4
PHYS 2326	University Physics II	3
PHYS 2126	University Physics II Laboratory	1
ENGR 2301	Engineering Mechanics: Statics	3
ENGR 2304	Programming for Engineers	3
or COSC 1436/1336	Programming Fundamentals	
ECON 2301 or 2302	Micro or Macroeconomics	3
	Semester Credit Hours	**17**

Second Semester (Spring)

	Course	SCH
MATH 2320	Differential Equations	3
ENGR 2305	Electrical Circuits I	3
ENGR 2105	Electrical Circuits I Laboratory	1
ENGR 2308	Engineering Economics	3
XXXX ####	Texas Core Curriculum Requirement	3
XXXX ####	Texas Core Curriculum Requirement	3
	Semester Credit Hours	**16**

Notes:

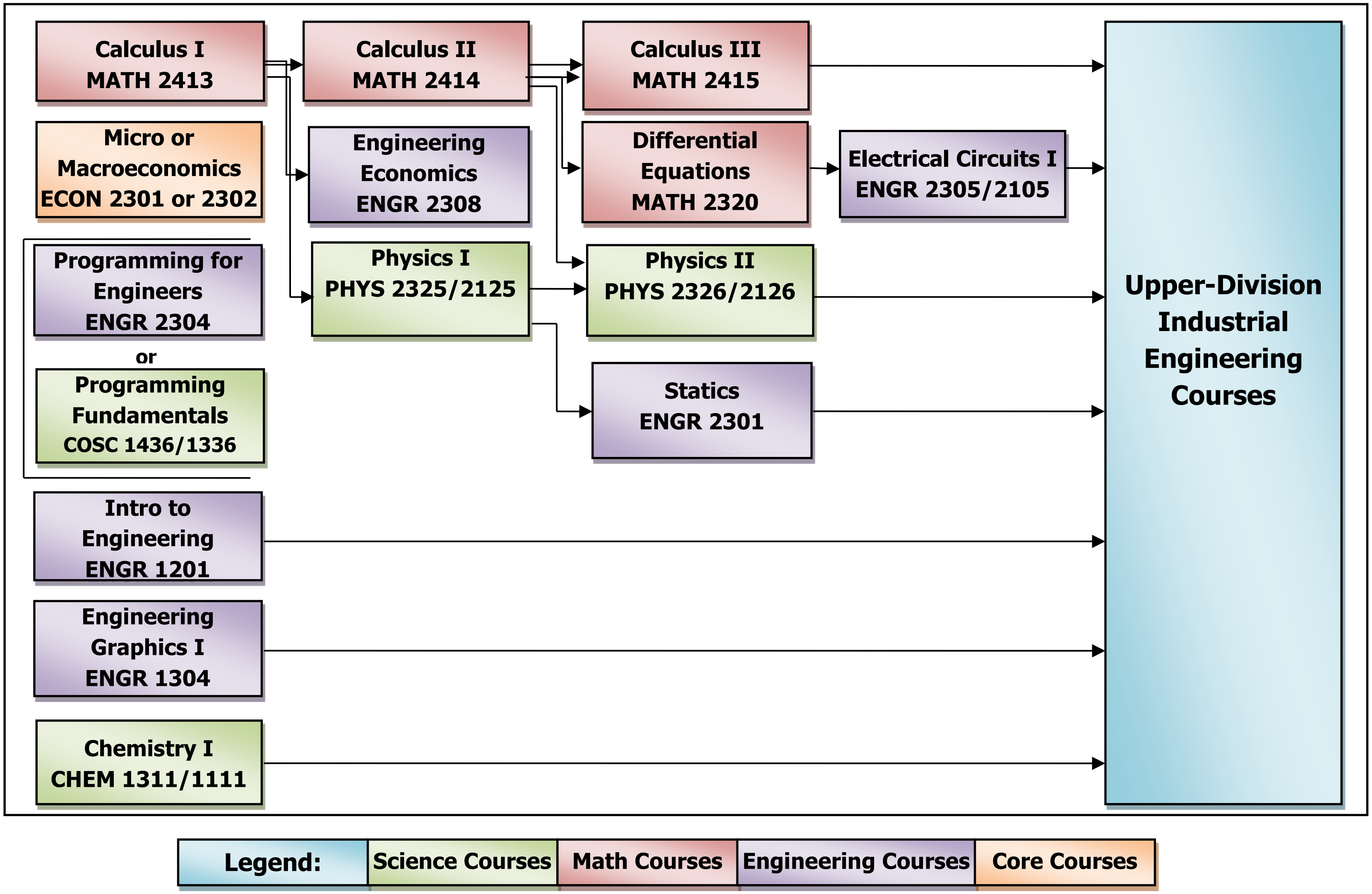
1. Texas Common Course Numbers are used for all TCCN-numbered courses.

2. Some industrial engineering programs require Chemistry II in addition to Chemistry I. The student is advised to check with the school to which he or she intends to transfer for specific requirements.

3. Some industrial engineering programs will accept the course ENGR 1201 for transfer credit and as applicable to the engineering major, while others will accept the course for transfer credit only. The student is advised to check with the school to which he or she intends to transfer for specific applicability of this course to the engineering major.

4. Industrial engineering programs will accept the course COSC 1436/1336 in place of ENGR 2304.

Prerequisite Flowchart



Note: Prerequisite Flowchart revised 11/15/2013 to reflect the Academic Course Guide Manual (ACGM) Committee's approval to modify the ACGM course ENGR 2308 Engineering Economics to remove the prerequisites ECON 2301 Principles of Macroeconomics or ECON 2302 Principles of Microeconomics.